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SPACE PHOTOGRAPHY FOR THE GEOGRAPHIC
STUDY OF THE EARTH

by

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B.V. Vinogradov

Space photography is a method used for recording the electromagnetic field of the Earth by means of photographs taken from spacecrafts located beyond the limits of the Earth's atmosphere. At the present time, a considerable number of space photographs of various landscapes of the Earth have already been obtained, the interpretation characteristics of which vary according to the spacecraft used, the photographic equipment, the sensitivity of photographic films, the altitude and optical axis of photography, the illumination conditions of the Earth's surface, the absence or presence of cloud cover at the time photographs are taken, and, finally, according to the techniques used for transmitting the pictures to the Earth. In certain fields of geographic studies, such as in climatology and oceanology, space photographs have already found a real and practical application, while in others (geology, biogeography) research is in progress on methods of effective utilization of such photographs.

Almost all types of landscapes occurring on Earth from the Arctic to the tropics have been photographed from space (Fig.1).

This fact permits us to make the first general statements in order to determine the potential and outline the possible means of development of cosmic photography for the geographic study of the Earth [2-4,6,20,22,28,29].

TECHNICAL ASPECTS OF SPACE PHOTOGRAPHY

Flight conditions of rockets or satellites, techniques used for transmitting images back to Earth, the stability, periodicity and recurrence of photographic methods - all these technical aspects are of particular significance in the methods used for space photography. For this reason, all space photographs can be classified into 3 groups according to the method and means used for obtaining them: 1)- photographs taken from sounding rockets; 2)- photographs taken from orbiting spacecrafts transmitting pictures directly to the Earth; and 3)- photographs taken by satellites regularly transmitting images of the Earth through television channels. Information

* Izvestiya Vsesoyznogo
Geograficheskogo Obshchestva

on the surface of the Earth can be obtained in the form of photographs, television pictures, geophysical data*, and visual observations**

SPACE PHOTOGRAPHY OF THE EARTH FROM SOUNDING ROCKETS

The first outer space photographs of the Earth were obtained at the White Sands range in New Mexico (USA) in 1945 from a V-2 rocket at an altitude of 120 km [28]. During the period 1946-1958 (i.e. prior to the launching of artificial Earth's satellites) at least 36 rockets of the V-2, Viking and Aerobee types were launched from this range [17, 21, 26], and took photographs of the Earth. Rocket photographs are taken from an altitude of 100-150 km. Many photographs were intended for plotting rocket trajectories and therefore were strongly oblique and included a picture of the horizon. At the same time, rocket photographing programs also included experiments aimed at selecting optimum parameters for future space photography from satellites. Thus, it was found already during the flight of Viking-12 (1955) that the use of an infrared film, which gives an image of the Earth's surface less subject to the effect of haze is promising for the use in outer space photography. Of all photocameras used in space photography, the best image quality was obtained during photography with standard aerial photocameras (for example, the K-25 model). This is not surprising since space photography is one of the variants of aerophotography.

The scale of rocket photographs varied within the range $1/3 \cdot 10^5$ - $1/3 \cdot 10^6$. Evaluation of the true resolving power was carried out on photographs of the El Paso region obtained with the aerial photocamera K-25 from a Viking-11 rocket in the original scale of $1/10^6$ and magnified 7 times. It was found that in space photographs with a calculated resolving power of about 200 m it is possible to recognize such details as streets, railroad tracks, canals and other linear objects with a width not exceeding 20-30 m. In the photographs

*) Sensitive receivers are capable of receiving from the Earth radiation of different wavelengths, ranging from ultraviolet to radar wavelengths. This range, on one hand, is considerable broader than the light sensitivity of photographic materials, and, on the other, can be localized by any narrow optimal sector. Thus, by measuring reflection in heat waves, it is assumed that information can be obtained on temperature differences on the surface of the earth reflecting the textural properties of surface formations, the lithological composition and the moisture content of surface deposits [7, 14]. In addition, infrared photography is an important adjunct of photography, since it allows continuing observations of the Earth's surface at night. The present review, however, is limited to traditional photographic methods for obtaining pictures of the surface.

**) In addition to those enumerated above, visual space observations, it should be noted that their performance both by the naked eye and with the aid of different optical instruments appears to be limited in comparison with the use of photographic sensors. Nevertheless, a

obtained large objects could be clearly seen, such as the Sierra-Nevada and Rocky Mountain Chains, outcrops of various rocks in plateaus and lower-mountain slopes, river basins and forests on mountain slopes, the Rio Grande valley and river bed, and the snow cover on mountains and hills (Fig.2). Comparison of data obtained in a second series of rocket photographs made it possible to identify the phenology of vegetation and the dynamics of the snow cover. After the launching of artificial earth satellites, investigators naturally devoted their principal efforts to the interpretation of photographs taken by spacecraft. Nevertheless, rocket aerial photography lost nothing of its importance, particularly for the solution of local problems. Thus, in 1963 a new program was launched for photographing the state of New Mexico using the Aerobee rocket in order to interpret, from the space photographs taken, the changes which took place in this territory during the period of over 15 years since it was photographed with the first Viking rockets.

In addition to the White Sands reservation, rocket photography has been carried out from ranges at Fort Churchill (Canada), Wallops Island (Virginia, USA) and Cape Kennedy (Florida, USA). Some of the rocket flights gave a clear image of the land surface, cloud cover and floating ice. However, these flights did not yield any significant geographic results [6, 18]. Space photographs obtained from the Atlas rocket (1959), launched from Cape Kennedy towards the estuary of the Amazon River, included a number of pictures of dry-land sectors in the marshy regions of Florida, West Indies Islands and tropical forests of Brazil. The photographing of subarctic regions with Aerobee type rockets (1960) launched from Fort Churchill was a definite success. These rockets took photographs of cloud systems, snow and ice covers, geological structures of the Canadian shield, lakes, forests and tundras in their spring and autumn appearance [8].

Photography of the Earth from Spacecraft. Photographing the Earth from orbiting spacecraft was started in 1960 as part of the Mercury (USA), Vostok and Voskhod (USSR), and Gemini (USA) flight programs. The suborbital flights of MR-1 (1960) and MR-2 and 3 (1961), similarly to those of sounding rockets, gave pictures of limited territories of Florida, the Bahama Islands, and the Atlantic Ocean [6, 24]. The orbital flight of the space station MA-4 (1961) yielded the first satisfactory series of space photographs of the Earth. This station took photographs of a strip extending from Florida to Lake Rudolph and gave good-quality pictures of the Earth's surface between the Moroccan coast line and Lake Chad [22,24]. These photo-

visual examination of the Earth from outer space was successfully carried out by the astronauts B. F. Bykovskiy, G. Cooper, A. A. Leonov and others and gave a number of valuable observations (different color shades of water in the area of the Bahama Islands smog distribution over San Diego, etc.,) prior to their observation on photographs [20, 23].

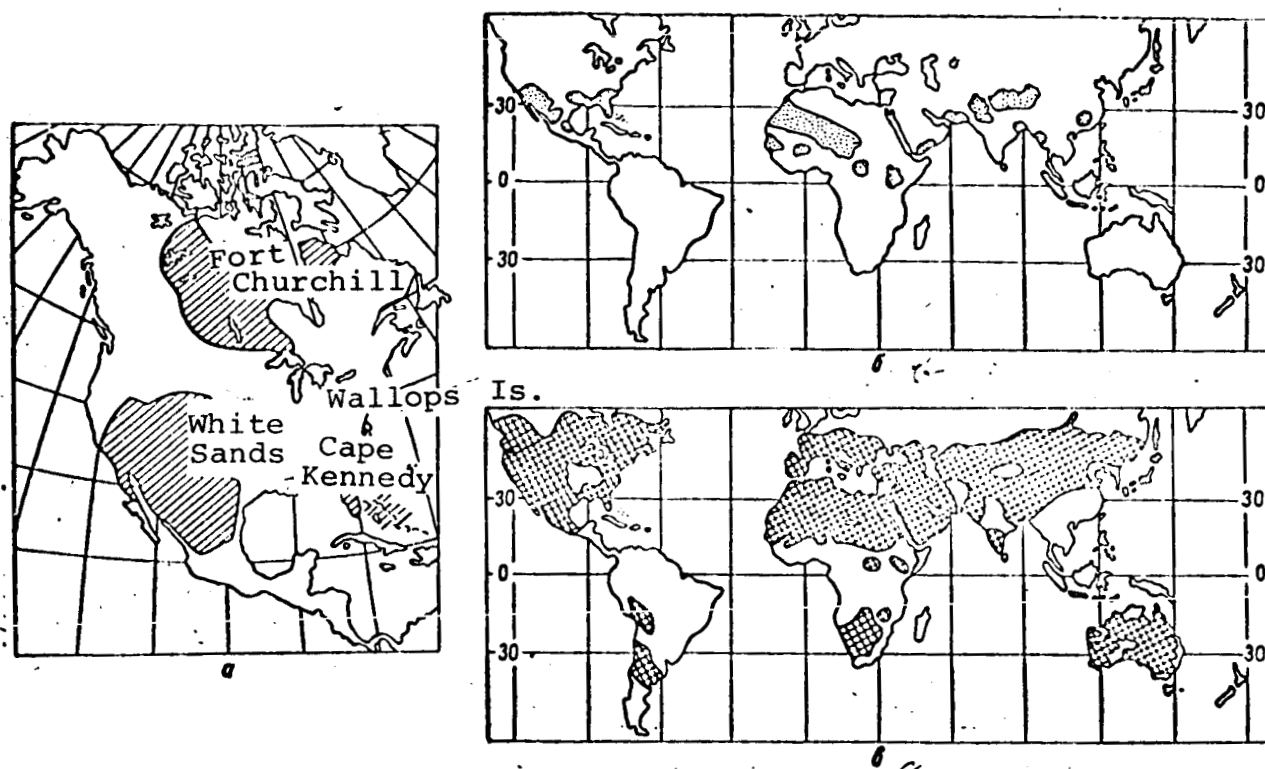


Figure I.

Areas covered by photographs suitable for use.

- (a) From sounding rockets, including nonorbital Mercury flights;
- (b) From Mercury space vehicles, and
- (c) From Tiros I, III and IV Satellites [22]. Space photographs suitable for use are those which give a picture of the Earth free of clouds and are not too oblique, and which exhibit shade variations sufficient to make recognition possible.

graphs cover the territory of Southern Morocco, Algerian Sahara, Southern Libya, and the northern portion of Niger. The space photographs clearly show the distribution of various rocks and their dislocated character, the longitudinal and transverse dunes of the Great Ergs, large wadis, the rocky deserts (hammadas) of the Draa, the Melrir the salt-bottom (solonchak) depressions (sebhi), the Atlas foothills, the Ahaggar island mountains and many other landscapes (Fig.3). On the southeastern pictures of this route it is possible

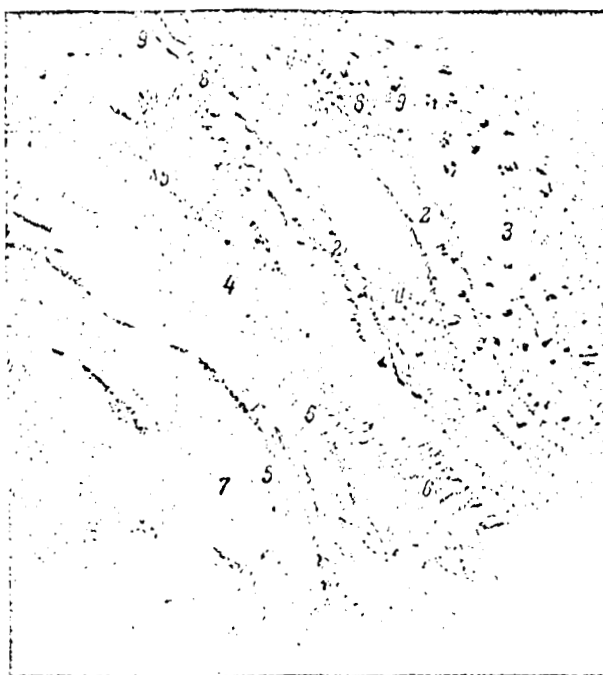


Figure II

Space photograph of the Rio Grande River area, obtained from an Aerobee sounding rocket fired from the White Sands Range. Photograph taken on 17 June 1963 from an altitude of 161 km with a camera of $f = 150$ mm, frame width 57 mm, visual angle 30° , on infrared film. Original scale about $1/10^6$ [22].

1. Valley of Rio Grande River with cultivated fields in various stages: dry and harvested - lighter sections, irrigated and with densely planted crops - darker sections;
2. Upper terrace of the river and boundaries of river valley;
3. High interior flat plains on old eolian deposits with sandy and sandy-loam grey-brown soils and shrub steppes (Yucca and Bouteloua species) in the state of Texas (USA); superposed are images of small cumulus clouds and their shadows;
4. Interior highlands on deluvial and proluvium deposits with creosote bush deserts (Larrea tridentata, Yucca and Opuntia species) in the state of Chihuahua (Mexico);
5. Brachy-anticline uplands and 100 to 150 m high ridges with noticeable contrast of lighted and shady slopes, consisting of clayey sandstones and chalk marls, on the northwestern plunge of the Sierra-Madre folded system;
6. Piedmont sloping plains consisting of proluvium trains with noticeable jet stream pattern of temporary runoff beds;
7. Closed clay depressions-plains;
8. Cities of El Paso, Ciudad Juarez and Isleta;
9. Highways and railroad lines.

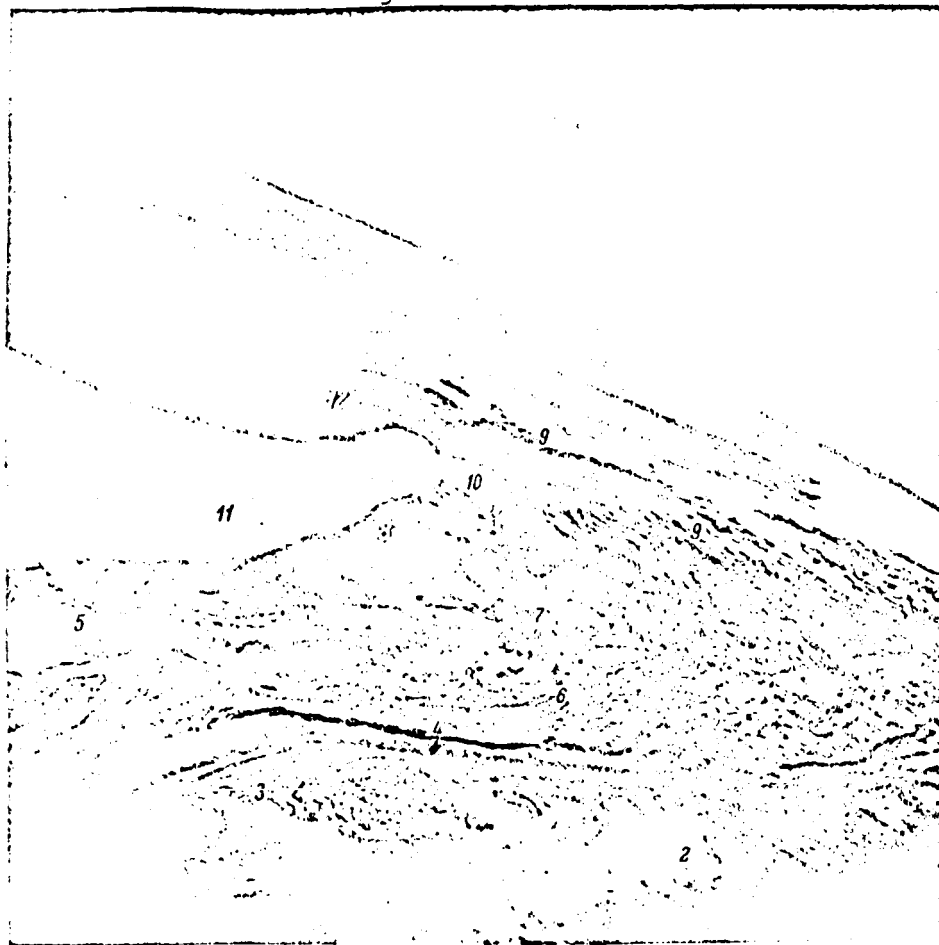
to identify the zonal transitions of the Sahara deserts to the desert and forest containing steppes and savannas of Sakhel.

The photographs obtained from Mercury-6, 7, 8 (1962) and 9 (1963) space vehicles were taken by the astronauts themselves using small size (70 mm) manual photocameras. High quality pictures were obtained with the Maurer-Hasselblad photocamera in the original scale of $1/2 \cdot 10^6$ - $1/5 \cdot 10^6$. The early opinion that the use of colored film is not promising for space photography of the Earth [16] was not confirmed. Photographs taken from the Mercury and Voskhod spacecrafts had a satisfactory color image with a weak effect of haze and scattered blue light.

During the flight of MA-5, approximately 25 space photographs of land areas were obtained, showing landscape types of the western Sahara, dune strips and the transition of deserts to savannas in the lower portion of the Senegal River-basin, the river system (network) and mountain topography of northwestern Mexico, the southern and southeastern parts of the USA with a picture of the hydrographic network, forest distribution and land cultivation forms. During the flights of MA-6, 7 and 8, a small number of dry-land areas free of clouds was also photographed in Oceania, in northwestern and western Africa, Florida, the southeastern USA, the west coast of Mexico, and the Gulf of Mexico coastline [6, 24 and others]. More successful was the space flight of astronaut Cooper aboard the MA-9 (1963), who obtained about 30 good-quality photographs of North Africa, Arabia, Iraq, India, Tibet and the Philippines. In these pictures it is possible to recognize clearly the relief, geological structure, glaciers, snow covers, land cultivation forms, run-off in near-estuary sea regions, and many other details.

Photographs taken from Artificial Earth's Satellites. Artificial Earth's satellites offer the possibility of continuously obtaining pictures of the Earth and rapidly transmitting these pictures to receiving stations by television. In the Tiros program (the Television and Infra-Red Observation Satellite) a total of 8 satellites were launched prior to 1965 in such a way that every sector of the Earth was located in the field of vision of at least one station [27]. The drawback of this system was the fact that the satellites had an equatorial orbit and therefore did not cover the entire surface of the globe and were limited to 65° northern latitude and 65° southern latitude. Receivers of the Tiros television system are sensitive to rays with wavelengths of 0.45 - $0.8 \mu\text{m}$, which corresponds to the sensitization of panchromatic and infrachromatic photographic materials [11]. The photographing is done at altitudes of 650 - 850 km on a very small scale of $1/12 \cdot 10^7$ - $1/24 \cdot 10^7$ and a frame size of $6.3 \times 6.3 \text{ mm}$ with medium-angle cameras and on a scale of $1/7 \cdot 10^6$ - $1/20 \cdot 10^6$ with narrow-angle cameras (Tiros I and II). These frames give a picture of an area of up to 1000 km^2 . The resolution of the pictures is generally low (about 3 km) and only pictures obtained with narrow-angle cameras from Tiros I and II reach a reso-

Figure III



Photograph of southwestern Morocco obtained from the Mercury-4 Spacecraft, taken on Sept. 13, 1961 from an altitude of 163.8 km with a Maurer camera, frame size 70 x 70 mm, $f=75\text{mm}$, visual angle 45° , optical axis inclination 72° to the northwest, on Anscochrome colored film. Original scale of frontal plane $1/22 \cdot 10^5$ [28].

1. Northern outskirts of the Hammada Draa (dark-grey fields intersected by light lines of wadis)-stony desert on limestones and conglomerates covered by a dark desert varnish with an extremely sparse undershrub and lichen vegetation;
 2. Denudation-accumulation submountain plain (Sahara piedmont) consisting of recent (lighter shade) and ancient (darker shade) argillo-shingle proluvium with cereal-undershrub subtropical semi-deserts (Aristida, Zizyphus species);

3. Hinge structure consisting of laminated rocks of the Carboniferous period (grey shade with noticeable curved banding);
 4. Low (relative altitude 200 m) Jebel Ourkziz, consisting of compact sandstones of the Carboniferous period (note the contrast between the southern and northern slopes);
 5. Littoral (maritime) plain consisting of alluvial-deltaic and eolian deposits with shrub deserts (Euphorbia, Lycium, Rhus species) (light-grey smooth shade with dark line of the Oued Draa bed);
 6. Ridge and hill strip of the western tip of Jebel Bani, consisting of clayey sandstones of the Silurian period (dark-grey shade with noticeable fine parallel banding);
 7. Intermountain valley depression of the Ifni River, consisting of schists and other soft Cambrian rocks with semi-arid sparse forests (Argania Spinosa); note the arched brachy-anticline structures (elliptic spots with axis orientation from South-west to North-east);
 8. Archean intrusive mass in the Ifni region with xerophytic tree-shrub vegetation (dark shade);
 9. High Atlas and Anti Atlas mountain ranges with coniferous forest vegetation (Pinus, Juniperus, Cedrus species), marked by cumulus cloud ridges;
 10. Maritime plain of Oued Sous with alluvial-marine deposits;
 11. Low stratus clouds above the sea, which break off sharply along the coastline;
 12. Cape Gir (or Rhir).

lution of 0.3 km. The resolution of the latter is comparable with that of photographs transmitted to Earth by space vehicles, but the area covered by the photographs is smaller in this case, and is reduced to 100 km². This fact was found to be so significant, since it was difficult to tie-in the photographs, that the use of narrow-angle cameras had to be abandoned in subsequent Tiros satellites. However, pictures obtained from Tiros satellites with narrow-angle cameras are precisely those which exhibit the greatest value for the geographic interpretation purposes.

Several hundred thousand photographs have been obtained with Tiros satellites, but only a very small number (less than 1%) are suitable for studying the land surface [6]. The vast majority of such Tiros photographs contain pictures of cloud formations or oceans, their obliqueness (perspective) is too great, and they show a lack of contrast, exhibit electronic noise and interferences during transmission to Earth, and are difficult to tie-in with the given location. In spite of their low resolution, the pictures transmitted from Tiros satellites make it possible to distinguish (identify) the structure of cloud formations, the boundaries of ice covers, the forms of macro- and mesorelief, the large features of a geological structure, certain types of vegetation, the contours of a hydrographic system (network), glaciers, water reservoirs and snow covers (Fig.4). Systems of this type are particularly effective in studying rapidly changing rhythmic and even catastrophic components of the landscape, such as the movement of atmospheric masses [9, 13], the changes in ice sheets (ice caps) [31], the dynamics of snow covers [10], the appearance of large fires [29], floods, etc. Even greater possibilities of practical application are expected from the Nimbus program, whose first satellite was launched in August 1964 along a sub-polar orbit. Nimbus photographs provide a greater resolution, are always vertical, and cover the entire Earth for a period of at least 24 hours [6]. At night, the photographs are taken by infrared radiation detectors in an atmospheric transparency window of about 4 μ m. [1].

ADVANTAGES OF SPACE PHOTOGRAPHY OF THE EARTH

The photographing of the Earth from outer space is essentially equivalent to a superhigh-altitude (at altitudes greater than 50 km) and ultrasmall-scale aerophotography, and the development of space photography is based on the use of techniques and methods used in taking photographs from the atmosphere (see note 3). At the same time, space photography exhibits a number of advantages over aero-

Note 3. Whereas in earlier years aerophotography was limited to "traditional" scales of $1/10^4$ to $1/5 \cdot 10^4$, the tendency in recent years is towards the use of "multiple scales" [30]. On the one hand there is noted the development of a superlarge-scale photography on

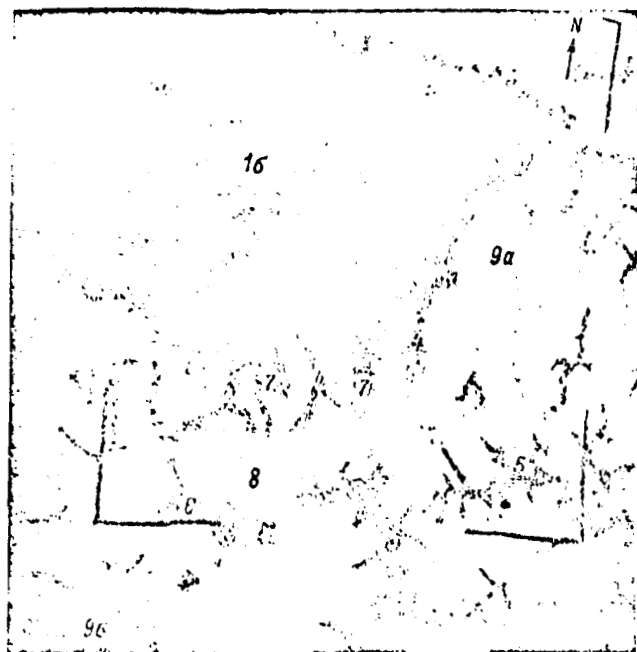
photography. These advantages can also be reduced to a generalization of geographic information in the following three directions.

Horizontal Integration. The principal of space photography is the possibility of achieving an extensive survey of the location and a territorial generalization of the structure of natural objects. Space photography covers an area of thousand, score of thousand and even hundred thousand square kilometers. On such photographs, we can observe large regional and global structures, we can find relations between distant objects, and we can study zonal regularities which are difficult to establish not only during ground observations but also in standard aerophotographs. Attempts to imitate space photographs (with a scale of $1/10^6$) by multiple reduction of photo-mosaics made up of small-scale aerophotographs (with a scale of $1/5 \cdot 10^5$) were unsuccessful: tone (shade) differences were distorted on these photographs as a result of multiple reproduction. In addition, such work would require the drawing of an enormous number of fine-precision photo-mosaics, which is practically impossible for many territories.

The small-scale character of space photographs, in addition to the extent of the area covered, also ensures a horizontal integration. Space photographs of the Earth have an original scale of $1/3 \cdot 10^5$ to $1/2 \cdot 10^7$. At such a scale, pictures of features of the Earth's surface become generalized and free of certain specific traits, and we thus obtain a picture of large structural features of the Earth's surface. The generalization of large-scale field maps by the usual cartographic methods in order to obtain small-scale review maps includes so many stages that the latter, as a rule, lose their specific (concrete) character. A territorial generalization, which is performed directly from the photographic picture, will allow a more objective process of compilation of special small-scale maps in the same way as in the compilation of large-scale maps from aerial photographs.

Vertical Integration. Aerophotography has already been used for a long-time as a means of assembling data on different components of the litho-, bio- and hydrosphere of the landscape by integrating their pictures in a single aerial photograph into a definite natural complex. However, the drawback of aerophotography lay in the fact that components of the climatic sphere (with the exception of certain microclimatic conditions) were excluded from the complex landscape represented in the aerial photograph. The use of space photography

a scale of $1/10^3$ and above (up to $1/10^2$) from helicopters, balloons and mobile towers which reflects the shape of individual plant crowns, the structure of phytocoenoses, etc. [25]. On the other hand, experiments are being carried out in ultrasmall-scale aerophotography on a scale of $1/10^5$ and smaller from high-altitude aircraft and stratospheric balloons, which yields large-size features of the structure of the Earth's surface [12, 15].



Photograph of the eastern part of Lake Issyk-Kul and adjacent territory obtained from Tiros-I on 21 May 1960 with a narrow-angle camera (12.7°), $f = 40$ mm, frame size 6.3×6.3 mm, original scale $1/17 \cdot 10^6 - 1/19 \cdot 10^6$, in a direction close to the vertical and transmitted to Earth by means of an automatic television transmission system (APT) [22].

1. Lake Issyk-Kul: deep water regions (a - depth greater than 50 m, even dark shade) and shallow water regions (b - even grey shade);

2. Coastal and gently sloping piedmont zone of feather grassworm-wood steppes (and mesophytic leaf-

shedding shrub steppes of the "shiblyak type) on proluvium and alluvium -proluvium deposits having a loessial appearance, cultivated to a great extent in the form of dry and irrigated farming, at altitudes up to 2200-2300 m;

3. River valleys in the piedmont plain with meadow and coastal water vegetation (Tyup and Dzhangalan Rivers, etc.);

4. Deeply incised, intermountain consequent river valleys on the northern slopes of the Terskei-Alatau range with meadow steppes and coniferous (mainly Tyan'-Shan fir) forests at altitudes up to 2600 (3000) m;

5. Deeply incised intermountain river valleys on the southern slopes of the Terskei-Alatau range, with meadow, feather grassworm-wood and shrub steppes at the same altitude levels;

6. Mountain wormwood-feather grass steppes and cushions of the Naryn River basin at altitudes up to 3000 m;

7. Subalpine mountain belt and range of elevated watersheds with subalpine meadows and sparse forests, mountain steppes and cushions; hillside wastes and bedrock outcrops at altitudes up to 3500 - 3700 m;

8. High-mountain belt with alpine meadows, high-mountain cushions and snow cover (permanent above 4000 - 4400 m) and small glaciers in the Kungei-Alatau, Terskei-Alatau, Akshiirak and Kuilyutau mountain ranges;

9. Regions of continuous (a) and variable (b) cloud formations.

allowed for the first time a complete integration of all components of the landscape from the geological structure to the upper layers of the atmosphere. A large number of examples has already been cited on the interpretation of the relationship between the structure of the cloud cover (and at the same time of meteorological conditions) and the structure of the surface. Thus, for example, in Figure 3, along the West coast of Africa where the relatively cold ocean mass of the Canary Island anti-trade wind flow comes into contact with the tropical deserts of Southern Morocco, a sharp boundary is noted between the continuous stratus clouds above the sea and the cloudless conditions above the continent. On the contrary, cumulus clouds drifting towards the Atlas mountain range are observed over the land. From space photographs it is possible to detect the connection between other landscape components, such as between the snow cover distribution and the relief; the lateral course of fractured, intrusive and fold geological structures the distribution of vegetation types, land cultivation forms and the structure of various landscapes.

Dynamic Integration. The presence of permanent orbital space stations makes it possible to obtain a picture of any illuminated part of the Earth at various time intervals ranging from minutes and hours to months and years. A comparison of successive series of photographs will permit us to study the dynamics and rhythmic character of natural processes in vast territories. At the same time, if the successive series of photographs are obtained by using a single photographing system, a high degree of correlation can be achieved. Photographs obtained from satellites by television methods can be used in the study of rapidly changing components of the landscape and catastrophic phenomena, such as the movement of cyclones and weather fronts, the dynamics of snow covers and ice caps, manifestations of volcano activities, the extent (size) of large forest fires and floods, etc. Photographs transmitted to the Earth from rockets and space vehicles are used for studying the dynamics of vegetation during seasonal periods and a span of many years, as well as the various forms of land cultivation.

Some Technical Advantages. A number of technical advantages pertaining to space photography over aerophotography should be noted. The absence of external vibrations, which greatly reduce the true (actual) resolving power of photographs taken from aircraft, is a favorable factor for obtaining photographs with a high resolution. Satellites can be equipped with aerial photocameras having unlimited long-focus lenses (up to several meters), provided the dimensions of these cameras do not interfere with the movement in outer space. This fact will make it possible to increase ground resolution and to obtain photographs with a scale of 1:50,000 [19]. By obtaining ultrasmall-scale photographs with long-focus cameras it is possible to improve their photographic quality as a result of a more uniform illumination (light exposure) of the negatives. If we take into account the large areas covered and the frequent repetition of the

photographic process, even with the high costs of the actual launching, it can be reasonably assumed that the cost of individual space photographs will generally not be too high. Finally, the presence of orbital space stations transmitting pictures to the Earth makes it possible to obtain the most "fresh" images of any illuminated and cloudless parts of the globe in response to the first request of a research scientist. Thus, a program is already available in the USA for supplying customers with rolls of film containing photographs of the Earth obtained from Tiros satellites [6].

C O N C L U S I O N

To conclude our discussion, we must mention a number of shortcomings of space photography and certain problems concerned with its development from the standpoint of geographic studies.

First, it is necessary to point out the most significant drawback of space photography as a whole: no single space flight instrument available (with the exception of the Arctic Meteorology Photo Probe program) has been built specifically for the purpose of photographing the surface of the Earth, and the photographing with these instruments was carried out as a supplemental operation of the flight program (mission). This fact explains why space photographs of the Earth's surface are still of low quality. To improve the quality of space photographs it is necessary to use somewhat more modern standard aerophotographic instruments and aerial films already utilized in aerophotography. The trend in the development of space photographic techniques is aimed at achieving a ground resolution of details not greater than 20 m, at obtaining photographs which are as vertical as possible, which meet the requirements of stereophotogrammetric processing, and which are received on earth at a constant and regular rate. It would be desirable that photographic images of the Earth be constantly transmitted from satellites through television channels for a preliminary decoding and also that such photographs be delivered to the Earth in containers. In view of the fact that the problem of a photographic study of the Earth's surface is a very complex and specific problem, it is necessary to work out requirements and build a special "geographic earth satellite".

The characteristic feature of space photography is that a considerable number of photographs of the Earth, containing extensive and varied information, is rapidly obtained. Extremely complex techniques are used in obtaining space photographs. The usual visual qualitative methods will not be able to provide a complete utilization of the information available in these photographs and a sufficient speed for their interpretation. For a rapid interpretation of space photographs it is necessary, first, to create a system based on small-scale aerophotographic data, of photographic standards with a scale of $1/10^4$ - $1/2 \cdot 10^5$, from which a tie-in and preliminary interpretation of

space photographs could be accomplished. Then, it is also necessary to build microphotometric decoding devices which would allow a more detailed analysis of space photographs.

Finally, if we consider the unique character of the data obtained by space photography, such data should be carefully systematized. A larger number of these data are of value only if they can be utilized immediately after their transmission or delivery to the Earth. It is indispensable that space photographs (in the same way as aerial photographs) be widely used and subject to an extensive interpretation by various specialists.

* * * THE END * * *

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